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To cite this article: Thomas E. Getzen (2016) Accuracy of Long-Range Actuarial Projections of Health Care Costs, North American Actuarial Journal, 20:2, 101-113, DOI: [10.1080/10920277.2015.1110490](https://doi.org/10.1080/10920277.2015.1110490)

To link to this article: <http://dx.doi.org/10.1080/10920277.2015.1110490>



Published online: 08 Jan 2016.



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# Accuracy of Long-Range Actuarial Projections of Health Care Costs

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The Office of the Actuary, mandated to provide projections of future medical spending for use by the U.S. Medicare and Medicaid programs, publishes forecasts that have been widely used by private firms and government budget officials as a baseline for expected long-run premium trends and to estimate liabilities for retiree health benefits. Although these projections have been made publicly available since 1986, they have not yet been subject to systematic evaluation by an external reviewer. This article develops a method for assessment of both short- and long-run accuracy and applies it to the 17 sets of projections made public over the last 25 years. The more recent set of projections (1998–2010) incorporating lagged macroeconomic effects appear to be more accurate than the older (1986–1995) projections that relied more heavily on demographic cost of illness trends. The average annualized error of the forecasts is approximately 0.5–1% per year, whether assessed over a span of one, two, or 10 years. Projecting “excess” growth in health spending (the rise in the share of wages or GDP) tends to be more accurate than forecasting nominal or real spending per capita.

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## 1. INTRODUCTION AND STATEMENT OF THE PROBLEM

Liabilities for future medical expenditures in the United States are trillions of dollars and rising (NAP 2012). Large employers with retiree health plans will require hundreds of millions of dollars in additional funding, and 40 states and thousands of municipalities already owe more than \$600 billion under current contracts (Clark 2009; Lutz and Sheiner 2014; Pew Charitable Trusts 2013). Uncertain medical costs are a major determinant of consumer budgets and form the single largest source of financial risk for the elderly (Americks et al. 2015). Improving forecasts and establishing likely ranges of uncertainty are important because doing so can force reluctant governments and firms to make hard choices, thus avoiding bankruptcy and protecting retirees. The U.S. Office of the Actuary (OACT) has published official projections of future medical costs since 1986, yet there has been no independent standardized assessment of these forecasts or any established methodology for doing so. Measuring the accuracy of these official projections is the task undertaken here. In addition to the ordinary research duties of reviewing prior literature and compiling data, three major contributions are made:

- A standardized method for measurement of long-run accuracy
- Comparison of ex ante OACT projections to actual data 1986–2012
- Empirical findings of greater accuracy for forecast of growth rates in share than nominal or real levels of spending, for post-1998 than 1986–1995.

Any standard measure of long-run forecast accuracy must resolve a number of technical issues: starting point, span, benchmark adjustments, and so on. Common measures such as RMSE (root mean squared error) or MAPE (mean absolute percentage error) need modification or replacement when applied to health spending projections for two reasons: (1) inflation and income affect medical cost growth with variable lags, necessitating normalized and conditional units of measurement and (2) factors creating short-run errors (one month to two years) are quite different from the factors responsible for long-run errors, necessitating measurement that extends beyond a single business cycle (five to 10 years). The cumulative annualized “excess” rate of growth in medical costs, equivalent to the rate of growth in health share (of GDP, total compensation, etc.), is the measure presented here. It

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is inherently scalable and normalized with regard to inflation and income. It is also transparent in calculation, applicable across a range of situations and data sets, easily understood, relevant to policy makers, and compatible with existing practice.

After a measurement procedure method has been established and the appropriate ex post actual outcome data specified, comparisons can be made to determine accuracy. The results obtained here of cumulative forecast errors on the order of 0.5–1.0% per year are similar to those reported by the OACT in its internal 2011 study and substantially smaller than the errors implicit in many commercial forecasts made by actuarial firms for retiree health plans.<sup>1</sup> Analyzing the composition of errors for five years or more demonstrates why excess (share) growth is better than nominal or real per capita costs for long-run forecasts but inferior over the short run. Examination of the earlier set of OACT projections (1986–1995) indicates why the later emphasis on system constraints and macroeconomic budgetary limits with lags enabled a significant improvement in the accuracy of long-run trend projection.

A credible forecast of long-run medical cost trends does more than just meet the needs of retiree health plans and Medicare trustees: It provides the shared background and implicit context for all of the hundreds of different premium estimates made by actuaries for specific employee groups and plans over the next few years. Even though each specific projection is usually more strongly influenced by local short-term factors and changes in benefit structure, they are all implicitly or explicitly compared to an underlying trend, a generally accepted standard for what the rate of increase is—or should be. This standard norm is reflected in media headlines and shaped by official projections from the OACT, supplemented by reports and surveys from actuarial firms and independent organizations.<sup>2</sup> Assessing the accuracy of existing forecasts is an crucial step in validating such estimates and improving them.

## 2. BACKGROUND AND REVIEW OF LITERATURE

The first comprehensive attempt to estimate U.S. national health expenditures was that made by the Committee of Cost of Medical Care and published in 1933 (Fetter 2006). Several projects were carried out to measure public health expenditures during the 1940s and supplemented with estimates of private health expenditures in the 1950s. The foundations of the current system of National Health Expenditures (NHE) were in place by 1965 and used earlier data to extend the annual series back to 1960. The OACT within the Medicare section of the Social Security Administration has made estimates of National Health Expenditures since then. However, the projections of future medical costs were irregular and essentially unpublished until 1986. A major effort to regularize the projections on a sound theoretical base was made, leading to extensive modeling focusing on demographic change and supply trends. Although initial results were promising, experience showed that this model was subject to significant errors in practice. After 10 years of experience, what had been primarily an age-sex-disease demographic projection was modified to incorporate more macroeconomic constraints and financial lags (Smith et al. 1998). Results from this modified process have been reported almost annually since 1999. Both the old and the new projections will be analyzed here.

Although numerous private estimates have been made of health insurance premiums and costs, most are for only one or two years ahead, are inconsistent in methodology and coverage, and are not routinely made public or evaluated ex post, making assessment of accuracy ad hoc and incomplete. The academic literature uses more formal methods, but almost all of the studies published to date are simulations or back-casting exercises that measure the closeness of a specific model to past data but do not test forecast accuracy by comparing projections with subsequent actual data (Getzen 1990, 2000, 2014b; Getzen and Poullier 1992). One assessment has been published of accuracy of the OACT projections conducted by the OACT staff, comparing year-to-year percentage changes with actual growth (OACT 2011a). This study examined one-year errors only (1997–1998, 1998–1999, 1999–2000, etc.) rather than accuracy over a span of years and found average annual errors between 0.3% and 0.8%. However, this leaves open many questions regarding how to define accuracy over longer periods, spans of observation, and adjustment for subsequent baseline data revisions.

Forecasts of GDP, inflation, employment, and interest rates are common. Analysis and evaluation of macroeconomic projections are well established and frequent. Housing, transportation, trade, agriculture, and many other sectors of the economy, some of them quite small, benefit from frequent and standard forecasts. Health care forecasting is relatively undeveloped. A substantial unmet need exists for forecasting from different sources and for consistent evaluation of methods and results commensurate with the importance and size of the health care sector.

For many years, it was assumed that population aging was a major, and predictable, driver of higher health care costs. It has become increasingly clear that this is not the case. The consensus among most forecasters now is that unexplained “excess” cost

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<sup>1</sup>See, for example, the series of Watson Wyatt (1995–2008) surveys reporting the means and ranges of estimated future medical cost increases for postretirement health benefits as compared to actual plan experience.

<sup>2</sup>See the reports on health care cost increases periodically produced by Milliman, Towers Watson, and other actuarial firms, IMS, Aetna, Universal, and other medical firms, or independent organizations such as KFF/HRET or HCCI, AHIP, and IFHP as reported in the *New York Times*, *USA Today*, *Wall Street Journal*, *Washington Post*, CNN, and other media outlets.

growth (due to some as yet unresolved combination of prices, technology, administrative efficiency, demand pressure, and other factors) is the major driver of rising health expenditures, with aging and other demographic factors playing only a minor role (CBO 2012; Getzen, 1992, 2014a; Leung et al. 2007; OECD 2006; Smith et al. 2009). This article assesses accuracy and does not explicitly investigate causal factors but follows that consensus in focusing on excess cost growth as the primary variable of interest in projections of future cost increases.

### 3. DATA AND METHODS

All 17 projections made public by the OACT before 2011 are compared with subsequent actual expenditures as reported in 2012 (projections made since 2011 do not have enough subsequent elapsed time to observe ex post accuracy). Documentation for each one is listed separately among the references as “OACT Projections.”<sup>3</sup> The first, published in spring 1986, used the official 1984 NHE estimate as a starting point and presented projections for 1986, 1988, and 1990. The second, published in summer 1987, extended projections out to 2000. Projections published in 1992 were extended out to 2020, but it was becoming evident that revisions and improvements were needed. The next, published in 1995, was for only 10 years. No more projections were publicly released until September 1998, when a substantially revised methodology was implemented (Smith 1998). Since then publication has become more regular. Projections are usually released in the spring of each year and extend for nine years into the future (i.e., those published in March 2010 provided projections for 2009 to 2019). Note that the lag in the availability of historical data means that upon publication in March 2010 the most recent actual official NHE estimate was for annual expenditures during 2008.

#### 3.1. Decomposition: Nominal, Real, and Share (Excess) Growth

Estimates of future spending are usually computed in three forms: nominal dollars, real per capita amounts, and as a share of gross domestic product (GDP). Decomposing expenditure growth into component factors such as inflation, population, income, and a residual or “excess growth” articulates the calculations linking these three forecast formulations. For current budgeting, costs are often expressed as nominal dollar amounts, while real inflation-adjusted rates of growth or as a share (of wages, income, total compensation, consumption, or GDP) are usually more relevant and meaningful over the long run.

The increase in total nominal health expenditure can be factored into increases in a nominal price deflator, in real per capita income, in population, and an excess growth rate that is equivalent to the percentage rate of growth in the share of health spending relative to income:

$$\% \Delta Health = (1 + deflator)(1 + income)(1 + population)(1 + excess) - 1.$$

Since share = (health ÷ income), a calculation of the rate of growth in the health share will cancel out all of the factors responsible for income growth and hence will be the same whether the variables are stated as total or per capita amounts or in nominal or real dollars:

$$\% \Delta share = \% \Delta (health/income) \approx \% \Delta health - \% \Delta income = \% excess growth.$$

More formally, let

$H$  = health expenditure

$Y$  = income

$S$  = share =  $(H/Y)$

<sup>3</sup>See Arnett et al. (1986), Division of National Cost Estimates (1987), Sonnefeld et al. (1991), Burner et al. (1992), Burner and Waldo (1995), Smith et al. (1998), Smith et al. (1999), Heffler et al. (2001), Heffler et al. (2002), Heffler et al. (2003), Heffler et al. (2004), Heffler et al. (2005), Borger et al. (2006), Poisal et al. (2007), Keehan et al. (2008), Sisko et al. (2009), and Truffer et al. (2010). These reports were “current law” projections, mandated to assume that no existing law will be changed, even when the staff are well aware that some provisions (such as the SGR [sustainable growth rate] limitation on annual Medicare payments to physicians) are routinely modified and are likely to be modified again in future years. However, the current law constraint will almost certainly continue since the authority to change law rests with Congress and is not to be second-guessed by technicians, even when they have good grounds for doing so.

with percentage rates of growth  $h$ ,  $y$ , and  $s$ , respectively, defining the excess growth rate  $x$  as equal to  $(h - y)$ . The percentage rate of growth in share can be expanded and then simplified to demonstrate the equivalence of share growth and excess growth:

$$\begin{aligned}
 s &= (S_t - S_{t-1})/S_{t-1} = [S_t/S_{t-1}] - 1 \\
 &= [((H_t)/(Y_t))/((H_{t-1})/(Y_{t-1}))] - 1 \\
 &= [((H_{t-1})(1 + y)(1 + x))/((Y_{t-1})(1 + y))/((H_{t-1})/(Y_{t-1}))] - 1 \\
 &= [(1 + y)(1 + x)/(1 + y)] - 1 \\
 &= (1 + x) - 1 \\
 &= x.
 \end{aligned}$$

“Excess growth” and “share growth” are computationally equivalent when expressed as relative percentage changes, and so the terms will be used interchangeably here.

This equivalence underscores a major reason to use decomposition and focus on excess (share) growth as the primary objective of the forecasts: It concentrates attention on changes in the health sector rather than on the background macroeconomic context (inflation, unemployment, business cycles, etc.). A health spending forecast ought to be conditional, that is, based on prevailing expectations regarding economic conditions. Corporate executives and legislators look to health actuaries for their knowledge of health systems and spending, not for expertise about the timing of the next recession or the implications of monetary policy.

However, because significant lags exist in the response of the health sector to macroeconomic variables, excess (share) growth is a good measure only for longer spans of time in which fluctuations get averaged out. “Share growth” can be very misleading in the short run. For example, the major recession that began in late 2007 continues to depress health expenditures even though employment and general economic activity started recovering in 2010. These inertial lags explain why the dollar share of the health sector appeared to decline in 2012 (down from 17.4% of GDP to 17.3%) even though health employment continued to grow faster than jobs in the rest of the economy. Lags in response to the spike in prices that pushed inflation above 10% in the 1970s meant that dollar measures understated the growth during the two or three years it took for that price surge to filter through to the health sector (Getzen 2013, 2014a).

The health sector is inertial with spending, responding only slowly to changes to macroeconomic conditions, and so the share (health/income) or difference (% health – %GDP excess growth) will have short-run monthly and annual fluctuations dominated by changes in income rather than changes in health spending. For example, in 1997 health spending rose 5.6%, but because GDP rose by 6.3%, measured excess growth and change in share was negative, –0.7%. Health care spending was not declining, but making the long-run trend in health system growth visible requires that the span of observation be longer than the five or 10 years of a typical business cycle.<sup>4</sup> The existence of timing lags, benchmark revisions, baseline normalization, and other data issues means that measures must be carefully specified to gauge forecast accuracy.

A quick glance at the March 2001 OACT projection for expected health spending in the year 2010 makes it seem uncannily precise: a forecast of \$2637 billion compared to actual expenditures of \$2594 billion (see Table 1 and Heffler et al. 2001, p. 194). Decomposition to separately examine the projections of inflation and income growth as well as the excess growth increasing the medical share of consumption suggests larger errors. The rate of excess growth for the health sector was substantially overestimated. This error was offset by the significant underestimate of the initial level and rate of growth in income. Only because these errors were of opposite sign did they cancel out and make it appear that the forecast for nominal dollar spending was close to the mark. A more detailed examination of this 2001 projection will be used to illustrate the methodology presented here.

### 3.2. Measurement Specification: Standardized Calculations for OACT Forecast Accuracy

Clarity and consistency are necessary to measure and compare accuracy but can be obtained only at a cost, a divergence between practice and concept. Benchmark revisions of data that change the course of history are a forceful reminder of this fact. Quantified variables (total costs, savings, household wealth, permanent income, life expectancy, etc.) reveal ambiguities, boundary issues, and judgment calls as they are closely examined. Technical specifications are needed to resolve such questions in practice, even though some may seem and indeed may be arbitrary. Listed below are the procedures used to establish uniformity here.

<sup>4</sup>From 1980 to 2010 the annual standard deviation in health spending per year is 1.6% and is reduced to 1.2% with adjustment for macroeconomic lags. In contrast, year-to-year variation in GDP is 2.6%. This adds variability to annual measures of share growth, making the standard deviation 2.5%, even though the long-run trend in share growth is fairly stable. More than 70% of annual spending variation is explained by lagging macroeconomic variables. See Getzen (2014a) for a more complete presentation of the econometric issues created by inertial lag responses in health systems.

TABLE 1  
OACT Health Spending Projection of March 2001 Compared to Actual 2010

	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
<b>Actual NHE</b>		<b>\$1,287</b>	<b>\$1,377</b>									<b>\$2,594</b>
growth %			7.0%									6.5%
projected NHE		\$1,211	\$1,311	error								\$2,637
growth %			8.3%	1.3%								7.2%
baseline error		-5.9%										error
												0.7%
<b>SHARE</b>		<b>.138</b>	<b>.138</b>									<b>.179</b>
excess (Share) growth			0.6%									2.6%
inflation			2.2%									2.3%
real GDP			4.1%									1.5%
projected SHARE		.130	.131									.159
excess (Share) growth			0.8%	0.3%								1.9%
inflation			5.1%	2.9%								3.0%
real GDP			2.2%	-1.9%								2.2%
baseline error		-5.4%										error
												0.7%

3.2.1. Data Sources

The *actual* health spending figures for each year used here to measure forecast accuracy are those reported by OACT in 2012 (Martin et al. 2012). *Forecast* values are taken from the projections published by the OACT in a series begun in 1986 and listed in the references at the end of this article. Actual annual population figures are those reported by the Bureau of the Census in the 2012 *Statistical Abstract*. Real and nominal actual income for each year is taken from the Bureau of Economic Analysis website in August 2012, with a deflator obtained as real income divided by nominal income each year, normalized to 2010. Any divergence between the levels or growth of health spending, income, inflation, or population as contained in the OACT projections and the actual data as reported in 2012 will affect measured errors. Benchmark revisions have sometimes made changes of more than 5% and must be accounted for in any assessment of forecast accuracy. While income and health expenditures have larger and more frequent revisions, it is the inflation deflator that is most often a source of contention or confusion. A strength of share/excess growth measures is the use of ratios, which circumvents the need for a deflator.<sup>5</sup>

3.2.2. Starting Point

The OACT projection published in March 2001 indicates that 1999 was the most recent year of actual data (Heffler et al. 2001). Spending for 2000 and 2001 was correctly labeled as projections even though these years were fully or partially in the past at the time of publication. Although any of the three years (1999, 2000, or 2001) could arguably be used as a start point for measurement of forecast accuracy, the last full year is used for consistency in this study. The disparity between projected and actual growth over the two-year span from that year forward (i.e., from 2000 to 2002) is termed the *two-year forecast error*. The last year of “historical” data (here 1999) is taken as the baseline, with any differences between data for that year as reported at the time of publication (March 2001) and data for the same year reported in August 2012 termed *baseline errors*. Disparities between projected and actual growth from the baseline year to the start year are termed *current errors*. Even though spending for the year prior to publication is technically a projection because the official OACT NHE estimate has not been released, in practice substantial information is already available regarding income, inflation, and health spending (i.e., for the projection published in March 2001, data for year 2000); therefore that last full year can be accepted as establishing a consistent place to define measurement of all baseline, current, and forecast errors in published OACT projections.

<sup>5</sup>Choice of a deflator for price-level changes always poses dilemmas, some of which are never satisfactorily resolved. Is the deflator to adjust for changes in the prices of specific items being purchased or of the supply costs of the productive resources? A specific price index for pharmaceuticals or hospitals or the elderly will not match the CPI or GDP deflator, leading to potential contradictions in comparisons of calculated rates of increase. Is quality being held constant, ignored, or subject to hedonic adjustment? How is the inclusion of new items that did not previously exist (robotic surgery, PET scans, Solvadi) to be handled? For consistent projection, matching supply and demand deflators is necessary to keep from distorting the relationship between prices and costs (i.e., *avoiding* a 2% rate for costs with a 3% rate built into investment returns or revenues) and is almost mandatory to keep projections from being misleading. Share or excess growth rates avoid the need for a deflator, a property that becomes increasingly desirable the longer the time span under consideration.

### 3.2.3. Time Span

The time horizon of a forecast is to some extent arbitrary, and multiple measures (current, two-year, five-year, and 10-year) are utilized here. What should be recognized is that different time spans will highlight different phenomena and may call for different methods (Getzen 2000). Measured growth from the historical baseline (1999) to the most recent full year (2000) projected can be dominated by revisions in reported GDP and health expenditure rather than actual expenditure increases. Short-run projections reflect current law, existing contracts, expected inflation, and temporary disturbances much more than long-run trends. The many factors creating year-to-year changes in the short run are mostly sources of noise in the long run, while the slowly evolving trend (which is hardly visible in month-to-month or even year-to-year data) grows to be the major issue. Temporary fluctuations and business cycle effects become moot as the forecast horizon extends to a decade or more where long-run trends dominate.

### 3.2.4. Amounts and Growth Rates

The 10-year projection is used as a guide to expected long-run changes in health insurance premiums, hospital rates, budget allocations, cost-of-living indices, and other medical cost trends. Annualized percentage growth rates are directly comparable. Future dollar amounts, whether real or nominal, total or per capita, are more difficult to interpret. Conversely, in short-run forecasts and budget projections, actual dollar spending on pharmaceuticals, on cardiac surgeries, or on a state Children's Health program may be more useful and more accurately estimated. In general, evaluations of accuracy in terms of percentage growth rates are more commonly accepted by forecasters and readily converted to absolute dollar amounts when necessary.

### 3.2.5. Trend and Variance Errors

Forecast accuracy is often assessed by measuring periodic (daily, monthly, annual, or decadal) variations, either as MAPE or RMSE (Armstrong 1985; Diebold 2012; Makridakis et al. 1997). These measures are appropriate when the series is stationary. However, with medical costs the major concern is uncertainty regarding the long-run trend rather than monthly or yearly fluctuations that will often offset and cancel out over time. Cumulative trend accuracy over a span of years is usually more important for policy than variance around a trend. Actuaries, insurance executives, financial regulators, and the Congressional Budget Office worry mostly about the growing gap between premiums and the ability to pay with incomes or taxes, not monthly or annual up and down variance as measured by MAPE or RMSE.<sup>6</sup> Therefore this study focuses on the cumulative difference between actual and projected spending over the entire span of the forecast as the most important measure of accuracy. Annualized percentage growth rates are used to facilitate comparisons among forecasts of differing lengths (i.e., two, five, seven, or 10 years) and for comparison with single-year forecast errors such as those reported in a recent OACT study (2011a).

## 3.3. Illustrative Example: 2001 OACT Projection for 2000–2010

The OACT projections published in March 2001 (Heffler et al. 2001) are used in Table 1 to illustrate the calculation of baseline, current, two-year, five-year and 10-year errors.<sup>7</sup> The last year of estimated actual spending then available was calendar year 1999 and is here termed the “historical” baseline. Even though the year 2000 had already ended, it is labeled as a projection because as of March 2001 official historical NHE data were available and public only through 1999. However, much of the relevant data for year 2000 (hospital utilization and charges, Medicare and Medicaid budget outlays, GDP, inflation, insurance premiums) were already available to OACT staff even if not yet presented in an official publication, making it hard to consider a projection of spending during the prior year as being in the same category as forecast spending 10 years into the future. What is here termed the *current year* (2000) is the most recent year prior to publication (and the first year projected) and is used as the starting point for calculation of two-, five- and 10-year growth rates, as well as being the endpoint for the assessment of the one-year error in projection from baseline to current year (*current error*).

The “historical” estimate of \$1211 billion for 1999 NHE is  $-\$176$  billion below the “actual” historical estimate for 1999 of \$1287 as reported in 2012. The difference of  $-5.9\%$  is a *baseline error* attributable primarily to benchmark revisions in the way NHE is estimated and what categories of expenditure are included or excluded, especially within the categories of long term care, over-the-counter medications, disability and mental health (OACT 2011b). Share (NHE/GDP) is underestimated by slightly less, 0.131 compared to **0.138**, a baseline error of  $-5.4\%$  (to assist in identification, italics are used for errors, boldface is used for actuals, and shares are in regular typeface as a fractions rather than percentages so that 0.131 means a health share 13.1% of GDP). The baseline error for share is slightly smaller than the baseline error for nominal health spending because GDP revisions between 2001 and 2012 were also upward (an old historical estimate of \$9299 billion compared to new historical estimate of \$9354 billion as reported in source documents although among the details not shown in Table 1). The current errors of  $1.3\%$  in growth of NHE

<sup>6</sup>The distinction between “trend” and “periodic variance” errors collapses when there is only a single period.

<sup>7</sup>Percentages occur frequently within the text, so the following typographical conventions are used as an aid in recognition: errors are in italics, projections in regular actual values are in boldface; shares are listed as three digits following a decimal point (e.g., 0.085).

(8.3% to **7.0%**) and 0.3% in the growth of share (0.8% to **0.6%**) are not large, but hardly negligible, given that this is a year that has already passed and for which much of the data have already been reported.

The nominal dollar projection for 2010 was very close to the actual amount reported in 2012 (\$2637 compared to **\$2594**), but the apparent accuracy of this forecast is quite misleading. The projected growth in nominal health spending from 2000 to 2010 was 7.2%, somewhat above the actual rate of **6.5%**. The dollar amounts are close because the trend error of a higher-than-actual rate of growth was offset by the baseline error of a lower-than-actual starting point. The opposite happens with regard to share, where the effect of a lower starting point (0.131 instead of **0.138**) compounds the effect of underestimating the growth in share each year for the next 10 years, so that the 2001 projection of the health share of GDP in 2010 (0.159) is well below the actual share of (**0.179**).

Would an objective observer assess the 2001 10-year projection as being “high” or “low?” The actual growth rate in nominal health expenditures in 2000–2010 of +**6.5%** can be decomposed into inflation (**2.3%**), real GDP (**1.5%**), and the excess rate of health spending above GDP (**2.6%**). In comparison, the projected growth rate of +7.2% assumed higher inflation (3.0%) and higher real GDP growth (2.2%) but lower excess growth (1.9%). The projection was low. The annualized error in nominal health spending is positive only because it incorporated an assumption of economic growth that was +1.4% above the actual, which happened to outweigh a lower (–0.7%) projected rate of growth in the health share of GDP.

The sign is important. The value of a projection rests upon the ability to indicate to what extent the costs of health care will exceed the ability to pay (wages, GDP, consumption, or other denominator). What worries insurers and payers is the disparity between income and expenditures, the “excess growth rate” (CBO 2012). It is the gap, not rate of inflation or nominal dollars spent, that threatens to massively enlarge the deficits of retiree health plans and the federal budget. Even though the +0.7% error in nominal NHE growth might suggest the forecast was high, the negative –0.7% error in excess (share) growth shows clearly that the forecast was low in the economically relevant dimension, underestimating the change in costs relative to the change in resources.

The primary target for a health spending forecast is *health*, not inflation, real income per capita, or population growth. Decomposition makes it evident why measuring the error in share (excess) is more conceptually and economically relevant than errors in nominal health spending and why errors in share will usually be smaller in magnitude over the long run. Inflation is so unpredictable over the long run as to make nominal dollar forecasts essentially meaningless after 20 or 50 years. A projection that something will cost \$80 or \$8000 or \$500 million in 2099 lacks context, whereas an estimate that medical insurance benefits will take 19% of wages or that national health expenditures will be 20–28% of GDP is meaningful (and even somewhat plausible).

#### 4. FORECAST ERRORS 1986–2010: EMPIRICAL RESULTS

The errors in historical baseline levels (amounts) and projected annual growth rates in nominal spending and shares from baseline to current year and current to two, five, and 10 years for all 17 published OACT projections from 1986 to 2010 are provided in Table 2, with a data set of all projections and actuals available from the author in .xls format.<sup>8</sup> The results of the earlier irregular projections 1986 to 1995 are separated from the more regular “annual” projections 1998–2010 to see the influence of the changes in methods. Mean absolute values are provided for the years available. The absolute average (i.e., ignoring sign and treating all errors as positive values) is provided at the bottom of each column.

Notable at the outset is that the largest errors are in the supposedly stable “historical” baseline amounts: more than 5% during the 1990s and more than 3% since then. Most of these “errors” are due to changes in methodology over time and during the periodic benchmark revisions, not differences in rates of increase or random fluctuations, and hence outside the scope of a forecast (Fetter 2006; OACT 2009, 2011b). These relatively large baseline errors reinforce the case for reliance on use of growth rates rather than levels to measure forecast accuracy.

Errors in the rates of growth from baseline to current year are usually 1% or less, a finding congruent with that of the OACT (2011a) evaluation. As the forecast horizon is extended further into the future, annualized errors are of the same order of magnitude (0.5–2%) but cumulated over longer periods, so that the final difference is of course substantially larger (i.e., an annualized 0.8% error compounds to 1.6% “trend error” over the two years from baseline to current, but to 8.3% in the longer 10-year projection).

<sup>8</sup>There is an inconsistency in the 1999 (Smith et al. 1999) projections that indicates a calculation error. In Exhibit 1 national health expenditures are shown as growing from \$1403.6 in 2001 to \$2043.1 in 2007. This is consistent with the 6.5% annual rate of growth Table 1, but not with the growth from a 0.146 to 0.160 share of GDP along with estimated inflation (2.9%), real per capita GDP (2.0%), and population (0.8%) over the same span. The 1.5% annual growth in share (i.e., excess growth) combined with the other factors leads to an estimate of annual NHE growth of 7.4%. Since the document does not provide much detail on GDP and other factors, and shows growth to a precision of only 0.1%, the exact source of the miscalculation is not discernable, nor is it possible to tell if it affects the 1999–2001 or 2007–2008 projections. Some possible sources are a final calculation that neglected to add population growth to per capita GDP or a typographical error that changed inflation to 2.9% rather than the 2.1% rate prevailing 1999–2001, either of which would yield an error of about the right size to explain the inconsistency. Lacking any means for second-guessing the published document, this article notes the inconsistency but uses the numbers as printed in Exhibit 1 of the document to calculate growth rates for NHE and Share reported here.



TABLE 2  
Forecast Errors for 17 OACT Health Spending Projections 1986–2010

<i>Published</i>	<i>Base Year</i>	Errors ( <i>actual - forecast</i> ) NHE Growth					Errors ( <i>actual - forecast</i> ) NHE Growth				
		Nominal Dollars					Health Share of GDP ( <i>excess growth</i> )				
		Current	Two year	Five year	10 year	5–10 Year	Historical	Current	Two year	Five year	5–10 year
1986	1984	-4.8%	-1.1%	0.6%	-1.3%	2.9	2.2%	-0.9%	-1.0%	-2.3%	0.0
1987	1986	-3.9	-0.4	-2.2	-1.3	2.9	1.9	0.4	-1.5	-2.0	2.0
1991	1989	-6.6	-0.8	0.9	2.4	2.4	-1.6	0.0	0.3	1.6	2.2
1992	1990	-8.0	1.2	2.7	3.7	2.4	-3.2	1.5	3.1	3.4	1.7
1995	1993	-4.0	0.5	2.1	2.0	-0.1	0.9	0.5	1.7	2.2	-0.7
<i>Average absolute values</i>											
1998	1996	5.5	0.8	1.7	2.4	2.0	2.0	0.7	1.5	2.3	1.7
1999	1997	-4.3	-0.4	-0.2	-0.9	0.4	-1.5	1.0	1.0	-0.6	1.0
2001	1999	-4.4	0.3	-0.1	-1.3	0.2	-1.6	1.2	1.7	-1.0	0.4
2002	2000	-5.9	1.3	-0.6	-0.5	1.8	-5.4	0.3	-2.6	-0.9	-0.7
2003	2001	-4.8	1.1	-1.1	-0.3	2.1	-5.1	1.1	-1.1	0.3	-0.6
2004	2002	-4.7	-0.9	-0.5	0.2	2.1	-2.7	-0.8	-0.1	0.5	-0.1
2005	2003	-5.1	-0.7	2.0	0.9	2.1	-3.3	-0.7	0.9	0.6	0.6
2006	2004	-5.4	0.4	0.6	0.9	2.1	-4.2	0.3	1.4	0.6	0.6
2007	2005	-1.2	0.6	0.9	2.2	2.1	-0.2	0.9	1.0	-0.1	-0.3
2008	2006	-2.0	0.2	1.3	2.3	2.1	-0.7	-0.2	-0.4	-0.3	-0.3
2009	2007	-2.6	-1.6	0.5		2.1	-1.3	0.8	-2.7		
2010	2008	-2.4	1.5	1.6		2.1	-1.1	0.0	0.1		
<i>Average absolute values</i>											
		3.8	0.9	0.8	1.1	1.1	2.6	0.7	1.1	0.5	0.6
		0.9	0.8	1.1	0.5	1.1	0.7	0.7	1.1	0.5	0.4

Source: Comparison of U.S. CMS OACT published projections with actual (2012) reported values.

Note: Average is for absolute value of all errors.

It is evident that the earlier projections from 1986 to 1995 are less accurate than the more recent projections from 1998 to 2010. Nominal errors are smaller than the share errors for the short-run two-year projections due to fluctuations in the denominator (GDP), while over a longer horizon of five or 10 years share forecasts perform better. Unfortunately, there are very few observations, with just three overlapping 10-year spans covered during the newer series. Therefore any assessments should be characterized as impressions, or perhaps as inferences that are not unreasonable but lack sufficient evidence to be conclusive. These projections are not only few in number but serially correlated, so that errors may be idiosyncratic and not indicative of what might be obtained from a larger and more random sample. Annualized errors for five or 10 years are larger than for current or earlier years, a finding that might be expected. However, the available observations were all affected by the recession starting in 2007, thus making any inference somewhat suspect.

It is probably reasonable, given many caveats, to say that the errors of the OACT NHE projections of nominal dollar spending have been in the range of 0.5–2% per year and usually becoming greater as the projection reaches out more years into the future. The share forecasts (excess growth rates) have annualized errors that are somewhat larger in the short run but smaller in the medium to long run of five years or more. The improvement in forecast accuracy since 1995 could be interpreted as indicating possibilities for future methodological gains. Conversely, the rather large errors in “historical” NHE suggest that measurement of health spending is inherently difficult and unstable, so that greater precision may not be possible or meaningful.<sup>9</sup>

## 5. CONFIDENCE INTERVALS, CAVEATS, AND CONDITIONAL PREDICTIONS

Since there are only a few forecasts for which actual long-run results are available, any assessment of errors and the ability to forecast long-run trends or turning points must necessarily be tentative and provisional. However, it is possible to examine the expected 10-year growth rates across all 17 published reports to gain insight into the methods and assumptions underlying the projections, and thus a better understanding of likely performance and problems. Figure 1 shows the projected 10-year growth rate in share (excess) for each forecast 1986 to 2012 compared to a smoothed actual (10-year trailing moving average). Three observations can be made: (1) older projections in the 1980s and 1990s were higher and more variable, (2) from 2001 to 2009 the projected 10-year excess growth trend was almost constant at  $2\% \pm 0.2\%$ , and (3) since 2010 expected share growth has been much lower, between 1.0% and 1.5%.

The process of adjusting expectations has been reactive. Excess growth rates surged after 1987, reaching almost +6% in 1991, and expectations were correspondingly raised in the projections, only to be quickly reversed as excess growth slumped and went negative in 1994–1997 (the peak is visible in Figure 1 but appears dampened and lower since the graph presents a 10-year moving average rather than single-year changes). After cost growth rebounded in 2001, however, the OACT appears to have opted to stay close to the long-run trend rather than attempting to make big adjustments for most of the decade until the recession caused a significant dip toward the end.

Among the many caveats that must be noted for the OACT projections, two stand out: “current law” and “expected macroeconomic growth.” Mandated by Congress to make projections assuming that current laws continue to hold (since to do otherwise would be to usurp the legislative prerogative of Congress), OACT must not only “hold constant” the unstable current policy context despite many predictable examples of routine amendment (such as the annual congressional override of the SGR [sustainable growth rate] limit on physician payments), it must also disregard the potential for major change in medical costs (somewhat like asking an actuary to project property losses in San Francisco disregarding earthquakes, or in Miami disregarding hurricanes). Any major turning point or seismic change in health care organization is probably ruled out because it would disrupt current law. Similarly, the use of accepted macroeconomic forecasts and projections as a base makes the projection of health care costs conditional upon the realization of the expected level of inflation and income growth.

The OACT projection thus is not a forecast in the traditional sense—the probability that actual losses will not exceed “X.” Instead it is a *conditional* projection, estimating the most likely outcome given a certain set of inflation rates, economic growth, and policy conditions. The accuracy of the projection should be assessed as being conditional on a given set of assumptions, which may later turn out to have differed significantly from the actual conditions experienced in the future. The *confidence intervals* most relevant to the task of OACT, as distinct from the external assumptions, are those with regard to the “unknown” parameter

<sup>9</sup>The literature on the methods and accuracy of macroeconomic forecasts is vast, too vast to cover here. However, it is possible to briefly present a few essential generalizations (and most importantly, that even the most commonly accepted generalizations are still subject to considerable contention and uncertainty). Most forecasters accept that there is a real limit to the accuracy of economic forecasts, with much greater uncertainty than the decision makers or the public generally believe or accept; that there is a trade-off among forecasting methods between minimizing the annual or monthly variance and predicting a cumulative long-run trend (bias); that short-run price-indexes are reasonably predictable while long-run changes in monetary base, quality, and new goods make such estimates problematic and perhaps meaningless; and that complex forecasting models are often less accurate than simple extrapolations and are almost always less transparent and more difficult to understand and apply.

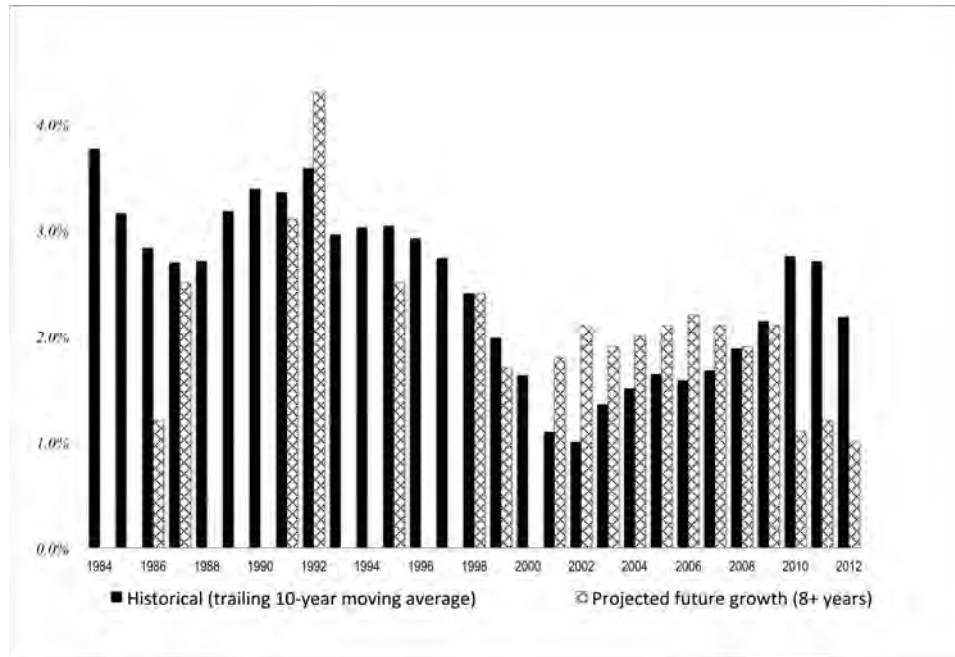


FIGURE 1. Historical and Projected Future Excess (% health – % GDP) Growth Rate in Spending. *Note:* The annualized rate of excess growth in national health expenditures (%NHE – %GDP) over the preceding 10 years is indicated by the solid black bars and is taken from the 2012 OACT publication (Martin et al. 2012). The projected future long-run rate of excess growth is indicated by the shaded blue bars and taken from the 1986–2012 OACT projections listed in the references. Projected long-run growth rates are shown for the “10-year” period, which usually ended nine years from the date of publication. However, the 1986 projection ends at 1988 (+2 years), and the 1992 projection extended out for 30 years (rate shown is for period ending in 2000). The 1999 projection has an apparent error in projected GDP, so excess growth is estimated from the change in projected health share of GDP rather than (%Health – %GDP). The percentage growth rates calculated either way should be identical except for rounding, but the NHE and GDP figures are favored because they are reported to four or five significant digits, while share is reported in just three significant digits. Note also that the excess growth gap since 2008 may have been temporarily widened by the unusually severe and unanticipated decline in GDP with effects persisting several years past 2012.

estimated: excess cost growth and change in the share of total income spent for medical care. Actual dollar spending in the future (real or nominal) is apt to vary more due to unforeseen macroeconomic shifts than health forecasting errors per se.

During the span from 1960 to 2010 the 10-year increase in the share of GDP has ranged from a high of 44% (1966–1976) to a low of 10% (1991–2001). This would suggest that an interval including those limits, with cumulative annualized rates ranging from perhaps 0.7% to 3.5%, might be expected with more than 95% confidence. In sharp contrast, however, the growth for the preceding 25 years (1929–1956) had essentially been flat around 0% (Seale 1959). Sometime between 1955 and 1960 costs began to surge upward in a sudden seismic change, rising so fast that medical costs doubled within a decade, even after adjustment for inflation. Hence any expected confidence interval should plausibly be asymmetric and more heavily weighted toward 0 and not so thoroughly rule out the possibility of an equally sudden reversion toward 0% excess growth in the future.

## 6. DISCUSSION: LONG RUN TRENDS AND “EXCESS” GROWTH

Projecting long-run changes in spending trends raises several issues. Is excess growth a function of technology, or tastes, or culture or policy? Is it independent of macroeconomic conditions, or is it perhaps a slowly evolving function of expected future income growth? Is medical care subject to “regime change” that could suddenly change the trend in costs? Inertia within health systems means that shifts in trend are hard to observe and interpret. Time-series observations over a sufficient span (decades or even centuries) are scarce and subject to difficulties in measurement. At present, the economics profession cannot even reach a consensus on whether productivity and household incomes in the United States are rising, constant, or falling—much less put reasonable boundaries on the uncertainty of the 75-year projections that must be used to project future Medicare and SSI trust-fund balances (Feldstein 2011; Gordon 2012; *Motley Fool* 2013). Expectations of growth in the go-go 1960s were well above those prevalent in the new millennium, and thus a slowing of spending might be expected for decades to come. The opposing cases for a reversion to the long-run stability of past centuries or a renewed technological surge appear equally likely. Given the inherent uncertainty in long-run economic projections, it seems unwise to expect significantly better precision from health spending forecasts.

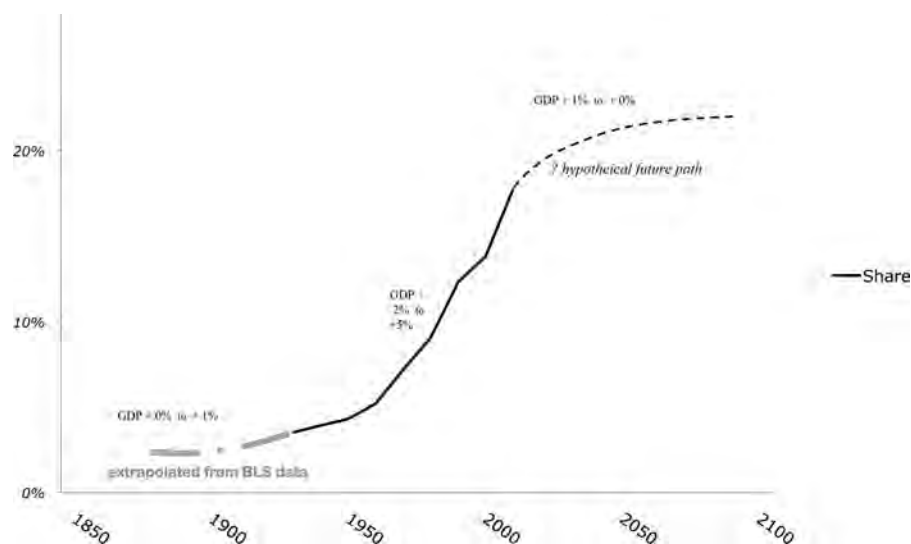


FIGURE 2. Health Share of GDP 1850 to 2100? *Note:* The actual share (National Health Expenditures/GDP) for 1930–2010 is indicated by the solid black line. Data for 1930 to 1960 are from *Historical Statistics of the United States* (2006, Millennial Edition). The wide gray broken line is an extrapolation of the growth in spending from 1850 to 1930 based on the ratio of health workers to total employees reported in Census Bureau decennial occupational statistics and supplemented by various Bureau of Labor Statistics surveys of consumption expenditures since 1888. Details of the calculations and data are available from the author. The dashed line from 2010 to 2100 is a speculative hypothetical extrapolation made by the author, based on the existing forecasts and the consensus of forecasts that the rate of growth must flatline (i.e., excess growth around GDP+0%) at some point within the next 100 years under any sustainable economic model.

Spending on health cannot indefinitely exceed the rate of growth in resources and is likely to hit a limit well before reaching 100% of GDP. Reasons why medical care has taken an increasing share of consumption, and will continue to do so, have been articulated by many notable economists even as they recognize that growth must stop well before it reaches this ultimate upper bound (Costa and Kahn 2004; Fogel 1999, 2009; Hall and Jones 2007; Newhouse 1977; Nordhaus 2002). Figure 2 presents actual data 1929–2010 and a hypothetical path for the succeeding years to illustrate a plausible course, a typical S-shaped growth curve. Arguably, the inflexion point of most rapid growth passed sometime in the 1970s, with the brief decline 1993–2000 and the moderating lull 2003–2006 representing halting steps toward eventual stability with a constant share (at 25% or 35% of GDP, or some other amount to be revealed in the future). Accepting this inflected curve as reasonable provides a framework for exploring long-run trends but also reveals the difficulties (nonlinearity, dependence on uncertain future incomes, varying elasticity, and potential changes in medical organization or technology similar in magnitude to the 1920s or 1960s).

## 7. CONCLUSION

The major conclusion of this analysis is that OACT projections since 1998 have performed fairly well, providing reasonable indicators of future medical costs for the next 10 years with a modest error (usually less than 1% per year), but are not predictive of major shifts or turning points, and may be of limited use over a longer run of 20 years or more—noting that we still do not have enough data or a sufficiently long series to provide a rigorous empirical analysis and make such conclusions any more than tentative. The larger errors in the earlier projections 1986–1995 indicate that the OACT team went through a useful learning process and that the current projection methods should be considered more reliable and accurate. That said, considerable uncertainty remains with regard to future trends. A major task of health actuaries, Medicare trustees, and the Congressional Budget Office is to simulate the effects of policy changes on spending, yet it has proven very difficult to do so. Past trends are of little use. Each policy is unique and apt to be influenced by external macroeconomic factors or endogenously generated, and the amount of change depends heavily on the extent of implementation and administration.

The primary target for a health care expenditure forecast is *health expenditures*, not income, inflation, or population. Forecasts of growth in these factors are not the responsibility of the health actuary. The OACT instead uses projections provided by the Social Security Administration for these external factors, supplemented by estimates from the Blue Chip Forecasters consensus. Hence the overall accuracy of their projections should be judged first and foremost on the basis of errors in excess cost growth/projected share rather than the magnitude of errors in nominal or real per capita spending. Simulations in billions of nominal dollars with attention to the allocation by payer and program category may be required to project the budgetary impacts of proposed legislation or the liabilities of retiree health plans, but the central concern remains the extent of excess spending and the disparate growth in health expenditures relative to wages and taxes.

The trend of future medical costs remains unclear, although it can be said with reasonable confidence that the health spending trend will be less variable than the growth of income. Uncertainty regarding future ability to pay is due partly to the cloudy prospects for U.S. economic growth as well as to the unknown relationship of desired health spending to income growth over the long run.

## ACKNOWLEDGMENTS

Thanks for helpful comments are due to Charles Roehrig, Paul Hughes-Cromwick, and Stephen Heffler.

## FUNDING

Parts of this work were funded by a grant from the Society of Actuaries.

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